INTERNATIONAL RICE COMMISSION

NEWS LETTER

Issued by the I.R.C. Secretariat, c/o FAO Regional Office, Bangkok, Thailand.

No. 11 September, 1954

THE WORK OF THE INTERNATIONAL RICE COMMISSION - PAST AND FUTURE

by

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Introduction

THE International Rice Commission formally came into existence on 4 January 1949. This was in accord with the terms of the Constitution drafted at the Rice Meeting in Baguio, The Philippines, 1-13 March 1948, which provided that the Constitution should enter into force as soon as notifications of acceptance had been received from the Governments of at least ten member countries of FAO, representing in the aggregate not less than half of the world production of rice in the crop year 1947-48. The Commission then held its first official session in Bangkok, Thailand, 7-16 March 1949. The forthcoming Session of the Commission, which is scheduled to be held in Tokyo in October 1954, may therefore be considered the fifth anniversary of the Commission.

The first five years of the Commission have been characterised by a number of changes both in the membership and in the activities undertaken. Since 4 January 1949 the number of countries adhering to the Constitution has increased from 10 to 23. Also, attention has been given to a wide variety of subjects in the several sessions of

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the Commission and the meetings of its working parties, and the subjects under consideration have varied considerably during those five years. There has been time for a considerable amount of sorting out of subject-matter, and as a result some items have received major attention while others have had only minor consideration in successive meetings or have been eliminated from the agenda, after consideration in only one or two Sessions or meetings. Delegates at the Fourth Session of the Commission will, of course, have to consider the future course of action with regard to the items on the agenda at that Session, and at the same time will no doubt wish to give careful consideration to the future course of the Commission's activities generally.

Summary of Subjects which have received Attention in the Past

A look into the future must inevitably be based on the happenings of the past, and the primary objects of this paper are to give a historical outline of the manner and extent to which various subjects have been treated in the Commission and its working parties from their beginning in 1949, and to call attention to some lines of work which might receive more attention in the future.

It is impossible to reduce to a simple tabulation all of the aspects of the rice industry which have been considered during the first five years of the Commission. However, an attempt has been made in this direction in the summary which is presented in Table 1. The headings under which various items were discussed at different times have varied somewhat, thus leading to one of the difficulties in making any complete and accurate tabulation. Therefore the items on the provisional agenda for the 1954 Session and meetings of the working parties have been used as a starting point. Working backwards, each of these topics has been traced to indicate when it first appeared on the agenda. Also, the times when other topics appeared on, or disappeared from, the agenda have been traced. These may be readily seen by an examination of Table 1.

The reader should keep in mind that Sessions of the Commission were held in 1949, 1950 and 1952, and that the Working Party on Rice Breeding held annual meetings from 1950 through 1953, inclusive. The Working Party on Fertilizers was initiated one year later and therefore held annual meetings in 1951, 1952 and 1953. In years when both the Commission and the Working Parties met, and particularly in 1950 and 1952, when it had been possible to initiate discussions on a fairly wide group of subjects, and before a number of topics had been dropped from the agenda, the total number of subjects was, of course, higher than in other years.

The subjects have been grouped under the relatively few major headings corresponding with the main subjects which have been under consideration in the Commission, the years in which they were discussed being indicated in Table 1 with an "-x-" to distinguish them from the subheadings for which the years are indicated by an "x". The major heading is marked as having been discussed when any one of the subheadings is so marked, as well as when

the major heading itself appeared on the agenda or in the report. The major headings include the following:

Improvement of Rice Through Breeding,
Improving Rice Production through Better Fertilizing Practices,
Improving Rice Production through Breeding and through Better Fertilizing Practices (to cover those topics which are of concern to both fields of interest),
Mechanization of Rice Production,
Other Rice Production Problems,
Development of Extension Services,
Reducing Losses Through Improved Operational Methods,
Utilization of Rice by-products,
Nutritional Aspects of Rice,
Economic and Related Aspects of the Rice Industry, and
Use of Rice Fields for Fish Culture.

Some of these subjects included as major headings in Table 1 have received only minor consideration, while others have formed the backbone of the Commission's work. The first and second of these headings cover the activities falling within the terms of reference of the Working Party on Rice Breeding and the Working Party on Fertilizers, respectively, while the third heading covers topics which have been dealt with jointly by these two working parties. Other subjects related to rice production and processing which have received a reasonable amount of attention in the Commission are those included under the main headings:

Mechanization of rice production,
Other Rice Production Problems, and
Reducing Losses through Improved Operational Methods.

However, no one of these subjects has as yet become the object of major consideration and action by the Commission in a manner such as has taken place for work in the fields of rice breeding and fertilizer practices.

The nutritional aspects of rice received considerable attention at the First and Second Sessions of the Comm'ssion, and particularly at the time of the Second Session of the Commission when a simultaneous meeting of the FAO Nutrition Committee for South and East Asia was held. A report of that Committee was incorporated into the report of the Second Session of the Commission. Since that time, however, only limited attention has been given to nutritional aspects.

Economic and related aspects of the rice industry received major attention at the first two Sessions of the Commission and limited attention at the Third Session. Topics under this heading have been eliminated entirely from the agenda for the Fourth Session in Tokyo. This situation arises from the fact that in the initial years of the Commission, rice was in short supply and countries were very much concerned with the economic factors related to that situation, even though international trade as such did not come within the terms of reference of the Commission. More recently, as the rice supply situation improved, the interest of Governments has shifted more to questions of international trade. Also a Special Rice Meeting was held in Bangkok, 5-16 January

1953, at which topics in this general field were discussed. Consultation with many delegates to the FAO Conference in November 1953 indicated that there was considerable uncertainty as to the extent to which delegates wished to discuss economic matters at the Fourth Session of the Commission. Further, some delegates expressed reluctance to have the Commission deal with economic matters although such matters are clearly within the terms of refernce of the Commission as set forth in the Constitution, with the exception of matters related to international trade. In the light of these discussions and the fact that there was some interest in further special rice meetings similar to that held in Bangkok in January 1953 or other means of consultation on economic problems which could include also matters of international trade, FAO found it necessary to eliminate topics related to the economy of the rice industry from the provisional agenda for the Fourth Session of the Commission in Tokyo.

Other major topics such as the use of rice fields for fish culture, the utilization of rice by-products, and the development of extension services have been discussed at various times but have never received more than cursory attention in the Sessions of the Commission.

The roots from which the discussions of most of the above topics grew extend back into the meetings held before the International Rice Commission came into existence, namely, the Rice Study Group which met in Trivandrum, India, from 16 May to 6 June 1947, and the Rice Meeting held in Baguio, The Philippines, from 1 to 31 March 1948. In fact, each of the so-called major topics referred to above, with two exceptions, namely "Utilization of rice by-products" and "Use of rice fields for fish culture", received attention at Trivandrum and Baguio. Many of the subtopics were not mentioned at these meetings but the main lines of interest of the Governments were certainly indicated. For example, under the topic of improvement of rice through breeding, only four of the many sub-headings which have been considered in subsequent meetings were actually mentioned at Trivandrum and Baguio. However, the interest of Governments in this major field of work was clearly defined and the breakdown of the subject into minor items has resulted from the work of the technical rice breeders participating in the Working Party on Rice Breeding. These workers have found it desirable to examine many topics, some of which were soon discarded, but others retained for continuing consideration. The same applies to the activities of the Working Party on Fertilizers.

While the subject of this paper refers to the future work of the International Rice Commission, it is not possible to indicate clearly the lines which may be taken since this is a question which must be decided by the Member Countries of the Commission. However, certain problems may be indicated.

As indicated earlier, only two major lines of activity have thus far been developed, and which have held a major place in the interest of the Commission from its beginning up to the present time. These are the activities carried out under the auspices of the Working Party on Rice

Breeding and the Working Party on Fertilizers. Some changes may be expected in the nature of the activities sponsored by each of these groups but in general the fields of activity may be expected to occupy the interests of the Member Countries of the Commission for many years to come.

Other Subjects which might receive Major Attention in the Future

Now that these two lines of activity are well established and beginning to produce concrete results, the question arises, "What other line or lines of activity should receive major attention?" Among possibilities are the following:

1. Improvement of Rice Storage and Processing:

This topic has received cursory attention in each of the Sessions of the Commission and also occupièd the attention of Governments at the meetings in Trivandrum and Baguio. It is a field in which considerable progress is clearly possible both to reduce losses during storage and to increase the efficiency of milling and other processing operations. Due regard should be given to nutritional considerations associated with processing and storage. Also, much may be accomplished through the improvement of handling and transportation facilities.

2. Mechanization of Rice Production :

Each of the three sub-items included in the provisional agenda for the Fourth Session under this general heading represents a field in which major improvements are possible. Improved equipment for lifting water for irrigation would clearly be an asset in many areas where facilities for controlling the water level are not yet adequate. Much might also be accomplished to reduce the drudgery of rice production through the improvement of small hand and animal powered equipment. Also in areas where Governments or private operators are interested in mechanizing rice production, many problems remain to be solved.

3. Soil-Water-Plant Relationships :

This complex of problems was first raised for discussion at the Third Session in Bandung, Indonesia, 12-16 May 1952. It has been discussed jointly at two subsequent meetings of the Working Parties on Rice Breeding and on Fertilizers. However, even though the subject is one of considerable importance, no clear-cut line of action for either the Commission or the Working Parties has emerged.

4. Use of Rice Fields for Fish Culture :

This field of work is of particular importance owing to the fact that full use of rice fields for fish culture would make available a great deal of animal protein to improve the diet of rice eating populations.

5. Economic Aspects of the Rice Industry:

The importance of the problems included under this heading need no elucidation since every Member Government of the Commission is keenly aware of the supply-demand and other marketing problems and of the problems of standardization of grades, qualities and terminology used in the rice trade. However, as explained earlier, there is some uncertainty as to the extent to which these problems should be handled in the International Rice Commission. According to the terms of reference of the Inter-

national Rice Commission, as set forth in its constitution, the Commission cannot deal with problems of international trade, although it can deal with other economic aspects of the rice industry. At its Seventh Session in December, 1953, the Conference of FAO discussed future periodic reviews of the economic aspects of rice and adopted a formal resolution (No. 16) requesting the Committee on Commodity Problems to arrange for a periodic review of the world rice situation and of other economic aspects of rice, and to consider the desirability and appropriate machinery for a review of the international trade in rice in which all interested Member Nations could participate. The method of implementing this request was considered at the meeting of the Committee on Commodity Problems in Rome, in June 1954, and the outcome of those discussions will be available to Governments prior to the next Session of the International Rice Commission in Tokyo.

Conclusion

Clearly, any body such as the International Rice Commission must, in planning and carrying forward its porgram, take into account:

1. The need for giving its attention primarily to those subjects which are of major concern to its Member Countries, and upon which those countries may expect to profit by some kind or kinds of co-operative or common action.
2. The need for continuing worthwhile projects over sufficient periods of time to obtain substantial results, in view of the inevitably long-term nature of most efforts at agricultural improvement.
3. The need for flexibility, so that new projects may be undertaken, while old projects may either be continued, or disbanded either because they have failed to yield worthwhile results or because a point of "diminishing returns" has been reached,

With these points in mind, the summary of subjects considered to date, which is presented in Table 1, and the notes regarding the summary which are presented in this paper, may be useful to delegates to the Fourth Session of the International Rice Commission as: (1) A handy check-list of what has gone before, and (2) An indication of some of the subjects from which delegates may wish to choose one or more for major attention in the future.

Table 1 – SUMMARY OF TOPICS COVERED IN SESSIONS OF INTERNATIONAL RICE COMMISSION AND MEETINGS OF WORKING PARTIES ON RICE BREEDING AND ON FERTILIZERS

Topic	Year					
	1949	1950	1951	1952	1953	1954
Improvement of Rice Through Breeding	-x-	-x-	-x-	-x-	-x-	-x-
Progress reports from countries			x	x	x	x
Training Centre on rice breeding		x		x	x	
Rice Hybridization project		x	x	x	x	x
Selection				x		
Field plot technique						x
Descriptions of standard varieties	x					
Genetic stocks of Rice		x		x	x	x
Resistance to lodging		x		x	x	x
Breeding for resistance to *Piricularia and Helminthosporium*					x	
Pests and Diseases in relation to rice breeding	x	x	x			
Resistance to shattering		x				
Tolerance to saline soils		x				
Tolerance to flooding and drought		x				
Time of maturity of rice		x				
Photoperiod response				x	x	x
Taxonomic relationships				x	x	
Milling and cooking qualities	x					
Nutritive value	x					
Cultural investigations in relation to rice breeding		x				
Seed multiplication and distribution		x	x	x	x	x
Seed disinfection	x					
Range of adaptation		x				
Varieties-transplanting interaction					x	
Double cropping of rice				x		
Rice improvement in Thailand				x		
World list of plant breeders				x	x	
Other technical discussions				x	x	

Topic	Year					
	1949	1950	1951	1952	1953	1954
Improving Rice Production through Better Fertilizing Practices	-x-	-x-	-x-	-x-	-x-	-x-
Fertilizer Investigations and Practices	x	x				
Methods of conducting field experiments			x			
Experimental designs for response curves					x	x
Reports from countries on N, P and K response curves						x
Training Centre on Soil Fertility			x	x	x	
Nitrogenous Fertilizers			x	x	x	
Phosphatic fertilizers			x	x		
Effects of phosphorous and nitrogen plus phosphorous					x	
Potassium			x			
Lime				x	x	
Micro-nutrients			x	x	x	
Free-living nitrogen fixing organisms				x		
Organic and green manures	x	x	x	x	x	
Chemical soil analysis			x			
Analysis of unoxodized paddy soils				x	x	
Time and method of fertilizer application			x			
Deep placement of ammonium sulphate				x		
Fertilizer placement					x	
Treatment of seed with plant nutrients	x		x	x		
Seed bed manuring				x		
Evaluation of financial returns from fertilizers			x			
Productivity of paddy soils in certain countries				x	x	
Soil fertility problems of China				x		
Fertilizer plans and programs in countries						x
Fertilizer production			x			
Rotations			x			
Other experimental work						x

Topic	Year 1949	1950	1951	1952	1953	1954
Improving Rice production through Breeding and through Better Fertilizing Practices			-x-	-x-	-x-	-x-
Varieties-fertilizer response interactions			x	x	x	x
Soil, water, plant relationships				x	x	x
Physiological diseases					x	x
Experimental designs for variety testing and fertility surveys					x	
Mechnization of Rice Production	-x-	-x-		-x-		-x-
Equipment for lifting irrigation water	x	x		x		x
Small hand and animal equipment for rice production	x	x		x		x
Power equipment for tilling and harvesting		x		x		x
Other Rice Production Problems	-x-	-x-		-x-		
General Conditions of, and factors affecting, Rice Production in various countries	x	x		x		
Upland rice production	x	x		x		
Hormone weed killers	x	x				
Forage crops for livestock feed		x				
Availability of draft animals for export	x	x				
Development of Extension Services			-x-	-x-		
Reducing Losses Through Improved Operational Methods	-x-	-x-		-x-		-x-
Storage of rice	x	x				
Rice Milling and Processing	x	x				x
Grading, drying, storage, handling and transportation						x
Parboiling						x
Transport equipment and storage material	x	x				
Utilization of Rice by-products	-x-	-x-				
Nutritional Aspects of Rice	-x-	-x-		-x-		-x-
Nutritional standard for rice		x				
Effects of storage and milling		x				

Topic	Year					
	1949	1950	1951	1952	1953	1954
Estimation of Thiamine		x		x		
Rice enrichment		x				
Parboiled rice	x	x		x		x
Preparation and consumption		x				x
Nutrition surveys	x					
Economic and Related Aspects of the Rice Industry	-x-	-x-		-x-		
Economic incentives for rice production				x		
Improvement of statistics on rice production	x	x		x		
Standardization of grades and qualities	x	x		x		
Rice Terminology	x	x				
Standard Conversion rates	x	x				
Rice Balance Sheet	x	x				
Forward estimates of rice production, consumption and trade	x	x				
Rice Marketing	x	x				
Study of cost of production of rice		x				
1950 Census Program	x	x				
Use of Rice Fields for Fish Culture		-x-		-x-		-x-
Physical aspects						x
Economic aspects						x
Total numbers of topics	33	50	23	47	29	31
Number of topics on rice breeding	4	14	8	17	18	12
Number of topics on fertilizers	4	3	16	17	16	9

PROGRESS REPORT ON THE WORK OF THE INTERNATIONAL RICE COMMISSION*

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FAO AGRICULTURAL ADVISER FOR ASIA AND THE FAR EAST

AND

EXECUTIVE SECRETARY, INTERNATIONAL RICE COMMISSION

Since the Third Session of the International Rice Commission, which took place in Bandung, Indonesia, in May 1952, the work of the Commission has been proceeding smoothly and steadily along the lines recommended by the Commission, with emphasis on the scientific and technical aspects of rice production promotion and the training of personnel. Of the 40 recommendations and requests made at the last Session of the Commission, 14 were made to member governments and the rest to FAO. Those recommendations and requests made to FAO were either carried out or are in the process of being carried out. The following is a summary of the highlights of the work of the Commission for the period under review.

Meetings and Reports of the two Working Parties of the Commission.

In accordance with the recommendation of the Commission at its last Session, the Report of the Third Meeting of the Working Party on Rice Breeding and the Report of the Second Meeting of the Working Party on Fertilizers were published as FAO Development Papers and already made available to all member governments.

The Fourth Meeting of the Working Party on Rice Breeding and the Third Meeting of the Working Party on Fertilizers were convened by the Director-General of FAO and held concurrently on 21-27 September 1953 in Bangkok, through the kind invitation of the government of Thailand. They were attended by 56 participants representing 19 governments and 3 international organizations. During the meetings 3 excursion trips were arranged by the host government to see rice selection and hybridization projects and fertilizer experiments in Bangkhen, Rangsit and Chiengmai. The reports of these two meetings have also been published as FAO Development Papers and will be placed before the Commission for consideration.

The Fifth Meeting of the Working Party on Rice Breeding and the Fourth Meeting of the Working Party on Fertilizers will take place simultaneously from 4 to 10 October this year in Tokyo and their reports will also be placed before the Commission for consideration.

International Training Centers on Rice Breeding and Soil Fertility.

In response to the recommendations of the two Working Parties at their annual meetings in Bogor, Indonesia, in April 1951, two international training centers were established by FAO in cooperation with the

* *To be submitted to the Fourth Session of the Commission which will take place in Tokyo, Japan, in October 1954.*

government of India for the benefit of member governments of the Commission. One was the International Training Center on Soil Fertility, which was held at the Agricultural College and Research Institute, Coimbatore, from 15 July to 15 October 1952. The course of instruction included lectures and demonstrations in the field and laboratory on field plot design, statistical analysis of experimental data, principles of plant nutrition and methods of testing soils for investigational and advisory purposes. A total of 19 trainees was enrolled, representing Ceylon, India, Indonesia, Pakistan, the Philippines, Thailand and Vietnam.

The other one was the International Training Center on Rice Breeding, which was held at the Central Rice Research Institute, Cuttack, from 15 September to 15 December 1952. The course of instruction included lectures on the principles of rice breeding supplemented by practical work in the field and laboratory in the design of experiments and analysis of experimental data; and by tours in rice growing areas where the crop was studied under varying conditions of soil, rainfall and elevation. Twenty-three trainees attended the course, coming from Ceylon, Egypt, France. India, Indonesia, Iran, Laos, Pakistan, The Philippines and Thailand.

The two Working Parties at their last meetings in Bangkok, Thailand, in September 1953, were unanimous in their opinion of the usefulness of such training and recommended that further similar training centers should be organized as soon as possible. This matter is now under consideration by FAO for 1955.

A National Training Center held in Thailand.

In line with the recommendation of the Third Session of the International Rice Commission, the government of Thailand held a National Training Center for the Grading and Inspection of Rice and Paddy and the Economics of Rice Storage Operations in Bangkhen with the assistance of FAO. The center opened on 2 March 1953 and lasted for 8 weeks, with an attendance of over 60 people. The center offered the following courses of study: Grading and Inspection of Paddy and Rice, Storage Technology, Storage Management and Administration, Paddy Storage Loan Program and Marketing and Pricing of Paddy and Rice.

Because of lack of sufficient evidence of interest on the part of the member governments, regional training centers on grading and inspection of rice and storage problems, (as recommended by the Commission at its Third Session), have not yet been held.

International Rice Hybridization Project.

The International Rice Hybridization Project, started in July 1950 at the Central Rice Research Institute, Cuttack, India, has been extended until the end of March 1956. It involves the cooperation of practically all the member governments of the Commission in the region, namely: Burma, Cambodia, Ceylon, India, Indonesia, Japan, Pakistan, The Philippines, the United Kingdom (chiefly in respect of malaya), Thailand and Vietnam. Since the progress report on the technical aspects of the project will be made to the Commission in other documents, the present report is limited to a financial statement on the project for the two year

eriod from 1 April 1952 to 31 March 1954, as the previous report, which was made at the last Session of the Commission, covered the initial period from July 1950 to 31 March 1952.

During the two year period under review, the total amount of receipts, including one contribution from Pakistan, four contributions from Ceylon, and support from FAO (from Expanded Technical Assistance Program Funds), together with the balance brought forward from the previous period, was Rs. 120, 481: 3: 9, against total disbursements of Rs. 65, 289: 13:3 for the project at the Central Rice Research Institute for the same period, thus leaving a balance of Rs. 37, 191: 6: 6. On the average, monthly expenditures amounted to about Rs. 3,000. For details, please refer to Appendix A. Further contributions are expected from its member governments for a successful completion of the project.

To facilitate the hybridization work at the Central Rice Research Institute, FAO made available in November 1951 Rs. 50,000 from Expanded Technical Assistance Program Funds for the construction of a pot-culture house. By the end of March 1954, there was left a balance of Rs. 1,907: 7:-. For details, please refer to Appendix B.

Small Farm Implements Publication issued.

In line with the recommendation of the Commission at its last Session, a publication entitled "Small Farm Implements" was made available by FAO as one of its Development Papers in June 1953. It contains 120 figures of hand tools and simple animal-drawn implements used in different parts of the world for soil preparation, sowing, planting, fertilizing, harvesting, processing and transportation. The purpose of this publication is to spread the knowledge of better tools and to provide farm implement experts, agricultural leaders and technicians with information on the principles governing the design of small tools and their use.

Continuation of the News Letter of the Commission.

The News Letter has been regularly published since its beginning in the Spring of 1952, four issues a year. Copies of the current issue No. 11, published in September 1954, will be placed before the Commission. A total of about 200 pages of 100,000 words has been published so far, covering about 60 articles contributed by 30 authors representing 10 member governments. The present circulation is 1,200 copies each issue and they are distributed according to a mailing list provided by the member governments of the Commission.

The Forthcoming Session of the Commission in Japan.

For those topics that need further discussion and action by the Fourth Session of the Commission, as listed in the Provisional Agenda, suitable working papers have been prepared. Regarding the planning of the future work of the Commission, a paper entitled "The Work of the International Rice Commission—Past and Present" has been prepared by Dr. Ralph W. Phillips, Deputy Director of Agriculture Division of FAO in

Rome, and appears in the current issue of the News Letter. This paper includes a table, listing topics that have been discussed in the meetings in the past and indicating when and how often they each came up for discussion. This will help to make the program planning much easier.

This report cannot be concluded without a word of appreciation to the government of Japan for its painstaking effort in planning and providing adequate facilities for holding the meetings of the Commission and its two Working Parties in Tokyo in 1954. The Executive Secretary went to Japan in May 1953 at the request of the government to assist in such planning, so that the active preparation for these meetings was started over a year ago. No one else can better appreciate than the Executive Secretary of the Commission the generous help that he is getting from the host government in making the arrangements for these meetings and ensuring their success.

Appendix A

Financial Statement on the International Rice Hybridization Project*

at the Central Rice Research Institute, Cuttack, India

(From 1 April 1952 - 31 March 1954)

Date	Receipts: From	Receipts: Amount	Disbursements	Balance
	Brought forward from 31 March 1952	Rs. 18,167: 2: 9		
Apr. 52			Rs. 2,088: 8: 6	
May 52			1,852:14: 3	
June 52	Pakistan First Contribution	4,928:13: 9	1,937: 0: 3	
July 52			2,006: 4: 0	
Aug. 52	Ceylon First & Second Contributions	9,862:13: 0	2,029: 5: 3	
Sept. 52			2,091: 2: 3	
Oct. 52			2,054: 9: 9	
Nov. 52			1,992: 9: 0	
Dec. 52			2,667: 5: 3	
Jan. 53			2,282:12: 6	
Feb. 53	Hq. Rome Third Contribution	59,525: 0: 0	2,476: 2: 6	
Mar. 53	Ceylon Third Contribution	4,998:10: 3	2,234: 2: 9	
Apr. 53			3,031:12: 0	
May 53			3,737: 0: 6	
June 53			3,290: 7: 6	
July 53			3,078:12: 6	
Aug. 53			3,265:13: 6	
Sept. 53			3,221:10: 6	
Oct. 53			3,198: 7: 9	
Nov. 53			3,349:15: 6	
Dec. 53			3,326: 4: 9	
Jan. 54			3,264. 8: 9	
Feb. 54			3,360: 7: 3	
Mar. 54	Ceylon Fourth Contribution	4,998:12: 0	3,451:12: 6	Rs. 37,191: 6: 6
	Total	Rs. 102,481: 3: 9	Rs. 65,289:13: 3	Rs. 37,191: 6: 6

* *The Government of India provides facilities and renders services at its Central Rice Research Institute for which no charges are made.*

Appendix B

Financial Statement on the Construction of a Pot-Culture House (FAO-ETAP Fund) at the Central Rice Research Institute, Cuttack, India

(From 1 April 1952 - 31 March 1954)

Date	Receipts		Disbursements	Balance
	From	Amount		
	Brought forward from 31 March 1952	Rs. 16,684:14: 0		
Apr. 52			Rs. 2,495: 0: 0	
May 52			3,181: 0: 0	
June 52			—	
July 52			—	
Aug. 52			1,280:14: 0	
Sept. 52			—	
Oct. 52			—	
Nov. 52			275: 0: 0	
Dec. 52			3,424: 6: 0	
Jan. 53			1,341: 0: 0	
Feb. 53			1,534: 0: 0	
Mar. 53			15: 0: 0	
Apr. 53			—	
May 53			—	
June 53			—	
July 53			—	
Aug. 53			—	
Sept. 53			—	
Oct. 53			—	
Nov. 53			—	
Dec. 53			—	
Jan. 54			1,186: 9: 0	
Feb. 54			44:10: 0	
Mar. 54			—	Rs. 1,907: 7: 0
	Total	Rs. 16,684:14: 0	Rs. 14,777: 7: 0	Rs. 1,907: 7: 0

REPORT OF THE INTERNATIONAL RICE HYBRIDIZATION PROJECT FOR THE PERIOD JUNE 1952 TO MAY 1954

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CENTRAL RICE RESEARCH INSTITUTE, CUTTACK, INDIA

The International Rice Hybridization Project has been in progress at the Central Rice Research Institute since August 1950. The Project, originally sanctioned for 3 years, was later extended up to March 1956 to achieve the following objectives:

1. To complete the original crossing program and to extend it to include crosses of ten further *indica* types from each of the participating countries with two new *japonica* types recommended by Dr. Morinaga of Japan as giving consistently high proportions of fertile hybrids in crosses with *indicas;*
2. To make back-crosses of the more sterile hybrids to the *indica* parents; and
3. To undertake cytological investigations of the causes of sterility in the hybrids.

Original Crossing Program

Under the original program, 33 *indica* types from nine South and South-East Asian countries (Burma, Ceylon, India, Indonesia, Indochina, Malaya, Pakistan, Philippines and Thailand) were to be crossed to 8 *japonica* types. At the request of Indonesia and Malaya 6 further cross combinations were undertaken. Thus, there were in all 270 cross combinations to be made. This program was completed by 1952-53, as was reported to the Working Party on Rice Breeding at its Bangkok meeting in 1953. The seeds from the F_1 generation of these cross combinations have been distributed to all the participating countries for growing the F_2 and further generations.

Extended Crossing Program

Sixty three new *indica* varieties were sent by the participating countries (details given below) for crosses under this program and the two new *japonica* varieties *Fukoku* (awned) and *Zuiho* were obtained from Dr. Morinaga. Crossing between these types is now in progress.

Country	No. of *indica* varieties received for the extended crossing program
Burma	10
Indochina	7
Indonesia	9
Malaya	10
Pakistan	6
Philippines	11
Thailand	10
	63

The following number of crossed seeds were collected up to 31st May 1954.

No. of cross combinations	Quantity of crossed seed collected
38	40 and above
1	30 - 39
7	20 - 29
9	10 - 19
9	Less than 10

The F_1 generation of these cross combinations will be grown during the 1954 crop season and the seeds will be distributed to the respective countries in 1955.

F_1 generation. During the period under review, 6,432 F_1 plants belonging to various cross combinations included in the original program were grown. The plants were healthy, very vigorous and showed marked heterosis. In 15 of the cross combinations, only a few plants could be raised due to poor germination of the seeds and therefore an adequate number of seeds could not hence be obtained in these crosses for raising the F_2 generation. The stubbles of these combinations have been kept for producing more seed in the 1954 season and it will not be necessary to make the crosses again.

The F_1 plants from the different crosses showed varying degrees of spikelet sterility. The data when plotted as a frequency curve give a normal distribution with a mode of 60 to 70 per cent sterility. The data do not show significant differences regionally or for any particular Japanese parent used in the crosses. A few instances of differential behaviour can, however, be found, e.g., the Burmese type D. 25-4 gives low sterility in most combinations while the other Burmese types give highly sterile hybrids. The extent of pollen sterility as calculated from iodine mounts was less than the extent of spikelet sterility in most of the hybrid combinations. This suggests that some of the fertilized ovules abort due to the zygotic combinations being lethal.

The crosses, in general, had been done using the *japonica* type as the female parent. However, the reciprocal cross was made in 49 combinations. Among these, reciprocal differences in sterility were less than 10 per cent in 27 cases; in 8 cases, greater sterility (over 10 per cent difference between the reciprocals) was found when *indica* was used as the female parent; and in the remaining 14 cases, the sterility was greater when *japonica* was used as the female parent. Hence it is inferred that in some cases the cytoplasm of either type is different as could be seen by the influence on sterility.

The two seasons of the year during which the hybrids are grown at Cuttack - July to November and January to May - are markedly different, the first being normal to tropical varieties and the second being unfavourable due to high temperature and atmospheric dryness. The April and May conditions cause increased sterility in the hybrids. Even parental types showed shrivelled pollen, reduced pollination and aborted ovules during this period. Small environmental differences may also have an effect on sterility. It was noted that there were differences in spikelet sterility between plants of the same cross grown during the normal seasons (July to November) in two different years.

Seed for F_2 generation. Seeds from the F_1 generation of the various cross combinations were distributed to all of the participating countries. The seeds intended for Indochina were sent to both Vietnam and Cambodia. Seeds for Pakistan were sent to East Bengal, Punjab and Sind. On the recommendation of the Working Party at its Third Meeting, seeds from the 49 cross combinations, which showed high fertility were also distributed to countries other than

those from which the concerned *indica* parents were obtained. Seeds of some cross combinations were also sent to Egypt at the request of Dr. L.E. Kirk, Chief of the Plant Production Branch, FAO, Rome.

F_2 and F_3 generations. The F_2 generations of the crosses made with Indian varieties were grown at the Central Rice Research Institute and by the Departments of Agriculture in Madras and Orissa States. A report on the performance of the F_2 generation grown in the 1952 crop season was submitted for consideration to the Fourth Meeting of the Working Party on Rice Breeding at Bangkok in September 1953. As mentioned in that report, a study of sterility was carried out in three F_2 families drawn from low, medium and high F_1 sterility classes. It was found that irrespective of the sterility of the F_1 parent, the range of sterility in the three F_2 families was practically the same and the coefficient of variability in all the 3 families was of the same order. It was therefore concluded that sterility was not a handicap in executing the breeding program, as even with high degrees of sterility in the F_1 equally good selections could be obtained as from more fertile F_1s. This view was further confirmed this year by the performance of the F_3 generation from the three F_2 families and from the study of the selections in various cross combinations in the F_3 generation.

A separate report on the performance of the selections in the F_3 generation and of the F_2 and F_3 generations from materials obtained under the *japonica-indica* project sponsored at the Institute by the Indian Council of Agricultural Research is being submitted for consideration at the 1954 meeting of the Working Party. However, it may be mentioned here that over 1,100 single plant selections made in the F_3 cultures are being carried forward for studying the F_4 generation. These selections appear to be very promising. They are early maturing (about 120 days in duration) and all yield over 35-40 gms., some of them yield even over 100 gms., while the mean single plant yield of the *indica* parents is 20-28 gms.

Back-cross Program

The Working Party at its meeting in Bandung in 1952 recommended that the more sterile F_1 hybrids should be back-crossed to their respective *indica* parents. Accordingly, 67 and 31 cross combinations which showed seed sterility of 50 per cent or more were backcrossed to their respective *indica* parents in the 1952 and 1953 seasons respectively. Owing to poor setting, seeds were obtained from only 48 of the 67 cross combinations back-crossed in 1952. The BC_1 generations of these combinations were grown at the Institute in 1953 and seeds for growing the BC_2 generation were despatched to the participating countries in March 1954.

The BC_1 generation of the 31 cross combinations back-crossed in 1953 will be grown at the Institute during the 1954 crop season.

Cytogenetic Studies

The meiotic division was studied in the microsporocytes of 85 hybrid combinations. In all of them the first metaphase stage was normal, twelve bivalents being formed. In the few megasporocytes studied the pairing was also found to be normal. Two to three

bivalents in all the cells were loosely paired, occasionally separating as univalents and tending to be pressed apart in smearing. This loose pairing could be due to reduced homology between chromosomes of the two parents of the hybrids. At the first anaphase of the pollen-mother-cell division, abnormalities were present in a few cells of most of the hybrids. These abnormalities could be classified as presence of laggards, stretched chromosomes, and anaphase bridges with fragments. A total of 5,600 cells were studied. In 33 hybrid combinations, irregularities were found in more than ten per cent of the cells and an anaphase bridge with fragments was found in eleven combinations.

The occurrence of anaphase bridges with fragments could be due to inversions in the chromosomes of the parents; and crossing over in the inversion region would give rise to these structures. The inference is that chromosome structural differentiation has been concerned in race formation.

Five highly sterile F_2 and F_3 hybrids were cytologically studied. Anaphase abnormalities were found in the first or second pollen-mother-cell division. The study is being continued.

In six highly sterile F_2 and F_3 hybrids which were selected for study, chromosome numbers in the root tips were found to be normal ($2n = 24$). Three plants with panicle abnormalities are also being examined for detection of possible aneuploidy. In the course of a search for aneuploids, two natural tetraploids were found amongst the hybrid cultures. It may be noted that natural tetraploids occur rarely in pure strains.

Hybrid seedlings were treated with colchicine solution for the induction of tetraploidy, and tetraploids have been secured and multiplied. Sufficient seeds of three allotetraploids from F_1 of ***indica*** x ***japonica*** crosses are now available for detailed cytological study. About 20 tetraploids derived from F_2 and F_3 hybrid cultures have been secured and also six autopolyploids. These have to be multiplied and studied. In the second generation of tetraploidy, genetic segregation for apiculus pigmentation was observed in the allopolyploid Taichu 65 x Adt. 12. A natural tetraploid from the F_2 of G.E.B. 24 x Taichu 65 gave uniform progeny and was stable. Cross pollination between tetraploids and diploids, for cytological and genetical analysis, is in progress.

RICE CULTURE IN JAPAN*

M. Maruyama

JAPAN FAO ASSOCIATION

Japan consists of four main islands-namely: Kyushu (south), Shikoku (south-east), Honshu (middle), and Hokkaido (north)—and a number of minor islands. Japan being predominantly a mountainous country, her arable land is rather limited. Paddy fields are mainly found on the plains, but they are also scattered in mountinous areas where rice can be grown.

The lowest temperature is in Hokkaido, and the highest in Kyushu. The average annual air temperature in the former (Asahikawa) is 6.7°C. against 16.9°C. in the latter (Kagoshima).

Out of a total land area of 369,842 square kilometers, 6,200,000 hectares are under cultivation, or one-sixth of the area. Cultivation in Japan is so intensive that a farm is often called a garden. One-third of the cultivated land is double- or multiple-cropped. The area in rice is about 3,000,000 hectares. The average farm is only ½ hectare in size but the yield is high.

In Hokkaido and in the northeastern parts of Honshu rice is the only crop grown during the warm season and the winter is too cold to grow a second crop in the rice field. In Kyushu, Shikoku, and in the southwestern parts of Honshu, winter-crops like barley, wheat and rapeseeds are grown in paddy fields except where there is trouble with water-logging due to the lack of drainage and irrigation facilities.

In Southwestern Japan, where climatic and soil conditions are more favourable, rice can be grown twice a year. Farmers in general cultivate rices of different maturity -early, medium and late - in order to avoid a rush at harvesting time.

Although direct sowing of rice seed is practised in some parts of Hokkaido, transplanting is the predominant method throughout Japan. A limited amount of upland rice is also cultivated, but production is only about 2 per cent of the total paddy rice production and the area under upland rice is less than 5 per cent of that under paddy Rice.

Rice Variety Improvement

Development of rice breeding in Japan. In Japan, rice is considered to have been introduced from China into Kyushu in the first century. From there rice planting spread northeastward. Toward the end of the 8th century, rice was introduced into Ou region (the northern part of Honshu). At the beginning of the 13th century, rice spread to the northernmost of Honshu. It was not until after 1870, when early-maturing cold-resistant varieties were discovered, chiefly by farmers themselves, that rice was introduced into Hokkaida.

Soon after the establishment of the National Agricultural Experiment Station in 1893, comparative tests were made on native vatieties collected from all parts of the country

* *Materials for the paper were provided by the authorities concerned in the Ministry of Agriculture and Forestry.*

with a view to selecting superior varieties best suited to the region in which they were to be grown.

In 1910, Dr. Terao set out to improve rice varieties by the pure-line selection method at the Rikuu Branch Station of the National Agricultural Experiment Station. Encouraged by the splendid results obtained, the pure-line selection method was practised widely throughout the country. About 10 years later, all the rice varieties recommended by the prefectural governments were obtained by this method.

In the meantime, Dr. Kato started hybridization at the Kinai Branch Station in 1904, and hybrid material was grown at four stations for observation and selection. As a result, in 1913, twenty hybrid strains were in use by farmers. Crossing between paddy rice and upland rice was started in 1920, while crossing between indigenous varieties and foreign ones was begun in 1922.

Meanwhile, the hereditary characters of rice were classified. This was of great help in the selection of suitable parent varieties for crossing.

In 1927 the entire country was divided into eight agricultural regions, each with a prefectural agricultural experiment station. These stations have since served as local breeding centers. The growing of F_1 and F_2 hybrids was limited to the National Agricultural Experiment Station (at the Konosu Experiment Farm). F_3 and later generations were grown at the local breeding centers, according to the observations made of the F_2 generations, until a promising strain or strains were found. If a promising strain was found to be superior to the existing ones, it would replace them in general distribution. All new strains thus developed were classified as "Norin" (Agriculture and Forestry) and each selection was given a number (e.g. Norin 1 or Norin 2). A total of 51 rice strains was thus developed.

In 1944, branch stations of the National Agricultural Experiment Stations were set up in Tohoku, Hokuriku, Takai, Chugoku, and Kyushu districts. After that, the hybridization program which had hitherto been carried out exclusively at the Konosu Experimental Farm was extended to these branch stations as well.

In 1947, the local breeding centers were brought under the direct control of the central government. Since then these stations have taken full part in the breeding work. In 1950, seven National Regional Agricultural Experiment Stations were established and most of the early agricultural improvement experiment stations were absorbed into these newly-established organizations.

These seven National Regional Agricultural Experiment Stations are located in seven different ecological agricultural regions and are responsible for the breeding of new varieties adapted to the region in which they are located. These stations are situated in Kotoni (Hokkaido), Omagari (Tohoku), Takata (Hoku-riku), Konosu (Kanto-Tosan), Tsu (Tokai-Kinki), Himeji (Chugoku-Shikoku), and Hainuzuka (Kyushu). In addition, there are six Prefectural Agricultural Experiment Stations, established at Aomori (Fujisaka), Miyagi (Furukawa), Fukui, Shimane, Miyazaki, and Kagoshima, each undertaking

a part of the rice breeding program. The National Institute of Agricultural Sciences in Tokyo lends its help in the breeding work by conducting basic studies on rice genetics and field techniques. The new strains of rice developed under this arrangement are given names other than "Norin Numbers."

Methods of breeding

At present, rice breeding in Japan is conducted chiefly by the pedigree method, although the bulk (mass) method and back-crossing are also sometimes used. Crossing is performed every year at each National Regional Agricultural Experiment Station. When the two varieties to be used as parents differ in time of heading, the late maturing variety is grown under short-day conditions so that it heads earlier and thus synchronizes with the other variety. In crossing, hot water at a temperature of 43°C. is applied for seven minutes. F_1 plants from 10 to 50 in number are grown for each combination, together with the two parent types for comparison.

The number of plants of the F_2 generation to be grown varies according to the combination, but it is usual to grow from 5,000 to 10,000 plants. These are transplanted and, at the rate of one seedling per hill, about 20,000 plants can be grown per tan.* For the selection of disease-resistant plants, seedlings are inoculated at an early stage. With respect to qualitative characters, such as heading time, kernel quality, height of plant, straw strength, and disease-resistance, about 1,000 individual plants are selected. As for F_3 and later generations, line selection is followed, though individual selection is also made from the F_3 generation. The number of plants of the F_3 generation to be grown ranges from 50 to 500 for each line and one seedling is transplanted in each hill.

For the F_4 and later generations, there should be at least four or five lines selected and each line should have 20 to 30 individual plants. Selections are made with reference to the heading time and other morphological characters revealed and to the results of tests for yielding capacity, disease resistance and other physiological characters. The tests are replicated from the F_3 generation onward.

The total number of places in the country where the tests for agronomic characters are carried out is 18, namely: 5 for blast, 3 for bacterial leaf blight, 2 for brown spot, 1 for stem rot, 1 for rice stem maggot, 3 for cold-resistance, 1 for lodging and 2 for other purposes. The point is to grow rice in places where diseases or insect pests occur more frequently.

Final yielding capacity tests are done at each National Regional Agricultural Experiment Station and also at each Prefectural Agricultural Experiment Station. Through these tests the scope of adaptability of a line to a region can be determined. Such tests are, therefore, known as "adaptation tests."

When a new strain is found superior to the existing ones after these tests it is given a regional number, like Tohoku 56, or Ou 224.

* *A tan = about 10 ares*

For the strains bearing regional numbers, further tests are made by the Prefectural Agricultural Experiment Station concerned under different climatic and other natural conditions in the prefecture to find out the yielding capacity and other characters in comparison with the existing varieties.

The Ministry of Agriculture and Forestry is responsible for final approval of a new variety according to the results of these tests and assigns a name to it.

Propagation and distribution of new strains. The new strains which have been fixed are maintained and kept pure by the experiment station at which they were developed.

Any prefecture wishing to introduce a new strain may obtain the seed from the original experiment station and grow it on foundation seed farms. The seed will then be multiplied on multiplication seed farms. Care must be taken to avoid mixture with other strains. The seed produced from the multiplication seed farms is distributed among seed associations.

Results of the breeding work. The yield of rice in Japan has been nearly doubled during the past five decades. The contributing factors are variety improvement and fertilizer application. However, along with the increased application of fertilizer, particularly chemical fertilizers, there comes a corresponding increase in disease infection, insect pest and lodging damage. It was only after disease-resistant and lodging-resistant varieties had been developed that it became possible to derive the full benefits of fertilizer applications.

The more recently developed improved varieties of Japanese rice tend to be shorter, with a larger number of panicles and tillers, and greater resistance to blast or other diseases and to insect pests, as compared with the varieties developed earlier.

The number of new rice varieties developed in the past ten yeras in Japan from 1944 to 1953 is as follows:

1943	1945	1946	1947	1948	1949	1950	1951	1952	1953	Total
4	2	4	4	13	7	11	6	9	4	64

Methods of Rice Cultivation

As stated earlier, rice cultivation in Japan varies from area to area according to local conditions and so it is not easy to explain it in detail. However, a typical method may be briefly described below.

Growing of rice seedlings. Rice seed are generally sown from late April to early May in Northeastern Japan, and in the first half of May in the southwestern parts of the country. A section of a suitable rice field, about one-thirtieth to one-twentieth of the total acreage of a rice farm, is used as a nursery.

The rice nursery is to be handled very carefully in order to produce healthy and uniform seedlings. Seedbeds are as a rule plowed to a depth of about 10 cms. in the previous fall and winter and fertilized with composts of four to five kilograms per *Tsubo**. Just before seeding time the nursery is irrigated, fertilized again, and puddled well.

**A Tsubo = about 3.3 square meters*

After that seedbeds are raised about 10 cms. high and 120 cms. wide. Ditches about 30 cms. wide are laid out between them, and standing water is kept in the ditches at all times. Ditches in this case also serve as passages for the farmer to work in the nursery.

Among the fertilizers applied to the rice nursery are ammonium sulphate, calcium superphosphate and plant ashes. The required amounts of the three elements per *Tsubo* are N, 40-60 grs.; P_2O_5, 30-50 grs.; and K_2O, 40-60 grs.

Rice seeds are first selected in a salt water solution of 1.08 to 1.13 specific gravity and then soaked in fresh water for five to seven days to force germination. The seed is generally treated with formalin or mercury compounds to control seed-borne diseases. Immediately after germination, the sprouting seed is broadcast evenly on the well prepared seedbeds.

The optimum seeding rate is 0.2 to 0.5 litre per *Tsubo*. Seeding is usually done by hand, but in some areas seeders have recently come into use.

After being sown, the seeds are lightly covered with soil or plant ashes. Thereafter irrigation, drainage, weeding, fertilizer application and disease and insect pest control operations are carried out at appropriate times.

The proper time for transplanting, when seedlings have attained a height of 20-30 cms. and have developed 6 to 7 leaves, is reached 40-50 days after sowing in the nursery in northeastern Japan, and 35 to 45 days after sowing in the southwestern parts of the country.

Preparation of paddy fields and fertilizer application. The paddy fields are prepared and fertilized for transplanting during the time when the rice seedlings are growing in the nursery.

First the paddy fields are plowed as deep as 15 cms., whilst composts or green manures (about 750 to 1,500 kgs. per 10 ares) are plowed under. Large soil lumps in the fields are broken up into small pieces. This is usually done with a horse-drawn or cattle-drawn plow but, in cases of small holdings, this operation is often done with hand tools. In recent years, power-cultivators (3 to 6 HP) or garden tractors (4 to 6 HP) have come into use.

Water is then put on the field to submerge the surface of the soil. Bunds enclosing the field must be reinforced by coating them with mud so that the water will not lead through. The soil saturated with water is harrowed thoroughly 2 or 3 times by using tooth-harrows or rotary harrows. Among the fertilizers used are ammonium sulphate and calcium superphosphate, and plant ashes and lime are also often used. The required amounts of the three elements per 10 ares are as follows:

N	7 to 10 kgs.
P_2O_5	5 to 8 kgs.
K_2O	5 to 8 kgs.

These fertilizers are commonly applied at the time of transplanting, but some quick-acting nitrogenous fertilizers are reserved for application before heading time.

Transplanting. The transplanting time varies

from district to district because of differences in climatic conditions and local traditions. In the northeastern districts transplanting is done from early June to mid-June, and in the south-western districts from middle to late June. From 50 to 70 hills per *Tsubo* are regarded as proper spacing in Japan. Clumps of 3 to 5 seedlings are planted in a hill with the fingers, to a depth of 2 to 3 cms. in the mud. One person can usually transplant 10 ares a day. In general a string marker is used as a guide for spacing, so that a space between four hills may form a square or a rectangle. If animal-drawn weeders are used for weeding and cultivation, seedlings are planted 40 to 50 cms. apart between rows, with a closer spacing between hills.

Irrigation. For about seven days immediately after transplanting the water is kept to a depth of 7-10 cms. in order to protect the plants. During the tillering period the depth of water is decreased to 2 to 3 cms. Fields are drained for about one or two weeks from the end of tillering to the beginning of the development of young ears. During the period from ear development to heading and flowering, fields are again flooded to the depth of 7 to 10 cms. After the period of flowering the depth of water is gradually lowered, and about 20 days after the end of flowering the water is completely drained.

Weeding. The first weeding is done 10 to 15 days after transplanting, and subsequently three or four weedings are done at about 10-day intervals. Weeding is usually done with hand-weeders, but sometimes with horse—drawn or cattle—drawn weeders. 2, 4—D has recently come into general use as a herbicide, except in the cooler regions. It is distributed with sprayers.

Top dressing prior to heading. Except in the cooler regions and on certain fertile lands, some portion of the quick-acting nitrogenous fertilizers is applied 20 to 25 days prior to the heading time at the rate of 1.2 to 1.5 kilograms (N) per **Tan.** In most cases, the top dressing with the quick-acting nitrogenous fertilizers is more effective in increasing yields than when applied in one dose before transplanting.

Harvesting. Even in the same region, the harvesting time varies with rice varieties. Generally speaking, in northeastern Japan rice is harvested from mid-September to early October, while in the southwestern parts it is harvested from early October to early November.

Harvesting is done with hand sickles. The straw is cut close to the surface of the soil in order to save as much as possible for industrial use. The cut plants are tied into bundles and are allowed to dry on racks, poles, or tree branches adjacent to the paddy fields. Drying is continued until the moisure-content in the unhusked grains has fallen to 15 or 16 per cent.

Threshing, husking, winnowing and milling. Threshing is most commonly done either with foot-pedal threshers or with power-driven threshers. The rough rice is spread over straw mate for drying in the sun for 4 or 5 days. In region with wet spells, rough rice is dried by heat.

Husking is done either with rubber roll huskers or with collision type huskers. Husks or chaff mixed in the brown rice are removed with winnowers.

Brown rice is milled either with milling machines of horizontal cylindrical friction type or vertical grinder type.

Rough rice, brown rice and milled rice are packed and shipped in straw bags. The common practice in Japan is to store rice in the form of brown rice in warehouses.

Rice Pest Control

Among diseases of rice in Japan are blast, sesame leaf spot, bacterial leaf blight, sheath spot and stem rot, and among the leading insect pests are rice stem borers, paddy borers and planthoppers.

In 1953 there was an exceptionally serious outbreak of diseases and insect pests and upprecedented control measures were taken.

Among the diseases, rice blast was the most serious. Owing to the inadequate amount of sunshine and to cool spells in the summer, this disease occurred widely over northeastern Japan. The total acreage of paddy rice affected by the two forms of the disease, leaf blast and neck rot, was 1,920,000 hectares. Among other diseases, downy mildew occurred more abundantly in 1953 in areas affected by floods than in average years.

Among the insect pests, the rice stem borer was predominantly serious. Owing to the unfavourable weather conditions during the early rice growing season in 1953, rice stem borer moths of the first generation emerged to an alarming extent, affecting an area of 1,070,000 hectares. The second generation of the rice stem borers was somewhat checked, but nevertheless affected 570,000 hectares. Although planthoppers occurred in some parts of Hokuriku District, they were less abundant in 1953 than usual.

In Japan, the control measures for these diseases and insect pests are carried out according to the Plant Protection Law. The government has a forecasting service for the occurrence of rice diseases and insect pests. In cases where control measures are carried out by rural communities or by farmeas' organizations in accordance with a government plan, the government is willing to provide the necessary chemicals, sprays, or dusters.

Among the chemicals used in 1953 were parathion compounds and mercury dusts. Parathion compounds have been proven to be an effective insecticide for rice stem borers. In 1952, parathion compounds were used on 60,000 hectares of rice fields. In 1953, parathion compounds were applied to 800,000 hectares. In addition 3% BHC dust was applied to 560,000 hectares.

The acreage of rice treated with mercury dusts rose from 30,000 hectares in 1952 to 300,000 hectares in 1953.

In addition, such insecticides as copper sulphate, copper-mercury compounds, and other copper compounds were also applied to 1,880,000 hectares of rice.

The amount of various agricultural chemicals consumed in 1953 for rice disease and insect pest control were as follows:

Copper sulphate	4,950 tons
Copper Compounds and copper-mercury compounds	3,660 tons
Copper compounds and copper-mercury dusts	4,950 tons
Mercury dusts	1,100 tons
Parathion emulsion	450 tons
Parathion dusts	8,440 tons
3% BHC dusts	14,400 tons
Total amount	37,950 tons

It is estimated that the decrease in rice production in 1953 due to the occurrence of diseases and insect pests would have been 2,250,000 metric tons, but some 50 per cent of this reduction was avoided by the use of control measures.

Processing and Storage

Processing. As Japanese rice varieties can be husked readily, the husking operation is carried out by farmers themselves shortly after threshing and drying. In most cases husking is done with rubber roll huskers. Rice is usually stored in the form of brown rice which is milled immediately before consumption. Rice is always milled at small mills, and then quickly supplied to consumers. The accepted milling rate is 94 per cent. This undermilled rice is often remilled to the rate of 92 per cent. This is known as white rice. In most cases a horizontal cylindrical friction type of milling machine is used which removes part of the bran layer. Recently a vertical type of machine, consisting of a vertical cylinder and a revolving grinder, has come into use.

Since husks, chaff, and particles of dirt are often mixed in the milled rice it is necessary to wash the rice before cooking. In this process a certain amount of starch or protein and a large part of soluble vitamins may be washed away, and attention is therefore being given to the possibility of producing milled rice that can be cooked directly without washing, by using milling machines to which are attached specially devised screens to remove the bran produced during the process of milling and to clean the rice.

Husks, constituting about 20 per cent of the paddy, are commonly used for packing purposes.

Rice bran is used mainly as stock feed. It consists of the outer part of the kernels, the germs, and a small amount of husks. Nearly 20 per cent of fat is contained in rice bran. Oil can be extracted from rice bran, but the rice bran oil contains wax and is liable to produce an acid on decomposition. For this reason, rice bran oil is not widely used for food purposes.

Parboiling rice is not common in Japan and is not needed because Japanese rice can easily be milled without breaking the kernels.

Milled rice is composed mainly of starch, and its protein-content is only 6.5 per cent. When the milled rice is taken as the main food, it results in protein dificiency. Its vitamin B_1 content is as low as 80 micrograms per 100 grams, and this is likely to be washed away before cooking. Rice-eating people are therefore liable to contract beriberi which is due to vitamin B_1 deficiency. In fact this disease is very common among the Japanese people. In order to prevent the trouble people have been encouraged to eat undermilled rice or germ-retaining rice to improve the diet, but as such rice is less attractive to the eye and not very palatable, it has not been extensively used in the country. The enrichment of rice with vitamin B_1 has recently been promoted to some extent in Japan.

The standard composition of Japanese rice is shown in the table below.

	Brown rice	Milled rice (Milling rate 96)	Milled rice (Milling rate 94)	Milled rice (Milling rate 92)	Enriched rice	Parboiled rice
	%	%	%	%	%	%
Moisture	14.5	14.5	14.5	14.5	14.5	12.5
Protein	7.5	7.1	6.8	6.4	6.4	6.6
Fat	2.3	1.6	1.2	0.8	0.8	0.7
Carbohydrate	73.4	75.4	76.3	77.4	77.4	79.1
Fiber	1.0	0.5	0.4	0.3	0.3	0.4
Ashes	1.3	1.0	0.8	0.6	0.6	0.7
	mg%	mg%	mg%	mg%	mg%	mg%
Calcium	9	7	6	6	6	—
Phosphorus	280	200	170	160	160	—
Iron	1.0	0.7	0.5	0.4	0.4	—
	mg%	mg%	mg%	mg%	mg%	mg%
Vitamin A (I.U.)	0	0	0	0	0	0
Vitamin B_1	0.40	0.30	0.25	0.08	0.60	0.35
Vitamin B_2	0.10	0.07	0.05	0.04	0.20	0.07
Niacin	5.0	4.5	3.0	1.5	1.5	4.2
Vitamin C	0	0	0	0	0	0

Storage. As mentioned earlier, it is a common practice in Japan to store rice in the form of husked rice, in straw bales or bags each holding about 72 litres (or 60 kgs. in weight) of brown rice. These are stored in warehouses which are owned by the government, agricultural co-operatives, or commercial firms.

These warehouses are built of materials of various descriptions. They may have wooden frames and plaster or concrete walls, or may be built of iron and steel, brick or stone, or reinforced concrete. However, buildings with wooden frames and plaster walls are most common.

Brown rice in Japan usually contains a high percentage of moisture, particularly that produced in Hokkaido, Northeastern Honshu and along the seacoast of Southwestern Honshu, which contains as much as 16 per cent or more of moisture. In Japan, owing to the high temperature and high relative humidity during the summer months, diseases and insect pests occur very frequently in the stored rice and special precautions must therefore be taken. In order to provide adequate ventilation, wooden blocks four inches square are piled up two or three deep on the floor of the warehouse at 5-inch intervals, and the bales or bags arranged in tiers upon them. The arrangement varies somewhat according to localities. At present, the government gives directions to arrange bales in tiers on a 4-bale cluster basis, and to arrange bags in tiers on an 8-bag cluster basis. It is usual to arrange in tiers 12 bales or bags high, and they must not be piled up

more than 14 or 15 bales high. Such an arrangement is regarded as the best in a country like Japan where the temperature and the relative humidity are high in the summer, but cannot be practised widely throughout the country, because of the lack of the necessary technique in making the arrangement and the limited amount of space in the storage.

During the months from May to October when the air temperature rises, the warehouse is fumigated with chemicals such as chlorpicrin or methyl bromide. About one pound of chlorpicrin or 0.65 pound of methyl bromide is applied for every 1,000 cubic Shaku or 3.03 km^3 of a warehouse, keeping the room airtight for about 72 hours.

The total number of warehouses and their total capacity in Japan may be listed as follows:

Warehouses	Number of houses	Floor Space (sq.m)	Capacity (M.T.)*
Owned by the Government	150	139,600	232,133
Owned by agricultural co-operatives	35,446	3,492,077	4,492,836
Commercial warehouses	5,828	2,542.109	3,768,110

Note: * *The capacity is sufficient to store all the food under the present food supply-demand plan.*

Printed and Published by

Mrs. PRAYAT JATAPUTRA at UDOM PRESS

395-401 New Road, Bangkok.

2/8/2497